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PROBLEMS.

54. Proposed by D. P. WAGONER, A. B., Principal of the School of Languages, Westerville, Ohio.

A man bought a farm for \$6,000 and agreed to pay for it in four equal annual installments at 6% annual interest compounded every instant. Required his annual payment. *B. F. Burleson.*

55. Proposed by J. C. CORBIN, Pine Bluff, Arkansas.

How long will it take to count a million, in the following manner: the counter is to pronounce each syllable in the names of the successive numbers at the rate of one per second?

◆

ALGEBRA.

Conducted by J. M. COLAW, Monterey, Va. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

46. Proposed by WILLIAM HOOVER, A. M., Ph. D, Professor of Mathematics and Astronomy, Ohio University, Athens, Ohio.

Find θ from $\cos\theta+\cos 3\theta+\cos 5\theta=0$....(1).

Solutions by JOE A. JOHNSON, Student of the Sophomore Class, University of Mississippi; E. L. SHERWOOD, A. M., Professor of Mathematics, Mississippi Normal College, Houston, Mississippi; J. B. FAUGHT, A. B, Indiana University, Bloomington, Indiana; J. C. CORBIN, Pine Bluff, Arkansas; G. I. HOPKINS, Department of Mathematics in High School, Manchester, N. H.; OTTO CLAYTON, M. B., Maxwell, Indiana; O. W. ANTHONY, M. S., Missouri Military Academy, Mexico, Missouri; and A. H. BELL, Hillsboro, Illinois.

I. Equation (1) $=\cos\theta+(4\cos^3\theta-3\cos\theta)+(16\cos^5\theta-20\cos^3\theta+5\cos\theta)=16\cos^5\theta-16\cos^3\theta+3\cos\theta=\cos\theta(16\cos^4\theta-16\cos^2\theta+3)=0$ ....(2). Whence $\cos\theta=0$. $\therefore\theta=\frac{\pi}{2}$. From $16\cos^4\theta-16\cos^2\theta+3=0$, we get $\cos^2\theta=\frac{3}{4}$, or $\frac{1}{4}$. $\therefore\cos\theta=\pm\frac{1}{2}\sqrt{3}$, $\pm\frac{1}{2}$. $\therefore\theta=\frac{\pi}{6}$, $\frac{5}{6}\pi$, or $\frac{\pi}{3}$ and $\frac{2}{3}\pi$, which are all the values $<\pi$. [*J. A. Johnson.*]

II. Factoring (2), $(4\cos^2\theta-3)(4\cos^2\theta-1)\cos\theta=0$. Whence $\cos\theta=\pm\frac{1}{2}\sqrt{3}$, $\pm\frac{1}{2}$, 0. $\therefore\theta=\frac{\pi}{6}, \frac{\pi}{6}\pi, \frac{5}{6}\pi, \frac{7}{6}\pi; \frac{\pi}{3}, \frac{5}{3}\pi, \frac{2}{3}\pi, \frac{4}{3}\pi; \frac{1}{2}\pi, \frac{3}{2}\pi$.

[*E. L. Sherwood.*]

III. From equation (2), we find $\cos\theta=0$; $\pm\frac{1}{2}\sqrt{3}$, or $\pm\frac{1}{2}$. $\therefore\theta=\frac{\pi}{2}$,

$\frac{\pi}{6}$, $\pi\pm\frac{\pi}{6}$, $\pm\frac{\pi}{3}$, $\pi\pm\frac{\pi}{3}$; or in *general*, $n\pi\pm\frac{\pi}{2}$, $2n\pi\pm\frac{\pi}{6}$, $(2n+1)\pi\pm\frac{\pi}{6}$, $2n\pi\pm\frac{\pi}{3}$, $(2n+1)\pi\pm\frac{\pi}{3}$. [*J. B. Faught.*]

IV. From equation (2), $\cos\theta=0$. $\therefore\ \theta=90^\circ, 270^\circ, \ldots.$ If $x=\cos^2\theta$, the second factor becomes $x^2-x=-\frac{3}{16}$, and $x_1=\frac{3}{4}$, $x_2=\frac{1}{4}$. $\therefore\ \cos\theta=\frac{1}{2}\sqrt{3}$ and $\cos\theta=\frac{1}{2}$. $\therefore\ \theta=30^\circ, 330^\circ\ldots,$ and $\theta=60^\circ, 300^\circ\ldots,$ for *particular* values. [*J. C. Corbin.*]

V. Contracting the last two terms of (1) into a *product of cosines*, by the formula $\cos x+\cos y=2\cos\frac{1}{2}(x+y)\cos\frac{1}{2}(x-y)$, we have $\cos\theta+2\cos4\theta\cos\theta=0$, or $\cos\theta(1+2\cos4\theta)=0$, $\therefore\ \cos\theta=0$, and $\theta=\frac{\pi}{2}$ or 90°, or in general $\frac{1}{2}(2n\pm1)$; also, $1+2\cos4\theta=0$, $\therefore\ \cos4\theta=-\frac{1}{2}$, and $\theta=30^\circ, 60^\circ$, or in general $\frac{1}{6}(3n\pm1)$. [*G. I. Hopkins*, *Otto Clayton.*]

VI. Equation $(1)=\dfrac{\cos3\theta\sin3\theta}{\sin\theta}=0$. $\therefore\ \cos3\theta=0\ldots.(a)$, or, $\sin3\theta=0\ldots.(b)$. From (a), $\theta=\frac{1}{6}(2n+1)\pi$; from (b), $\theta=\frac{1}{3}n\pi$. [*O. W. Anthony.*]

VII. $\cos3\theta=\cos\theta\cos2\theta-\sin\theta\sin2\theta$; $\cos5=\cos\theta\cos4\theta-\sin\theta\sin4\theta$. $\sin\theta=\sqrt{1-\cos^2\theta}$, $\sin2\theta=2\cos\theta\sqrt{1-\cos^2\theta}$; $\sin4\theta=4\cos\theta(2\cos^2\theta-1)\sqrt{1-\cos^2\theta}$, $\cos2\theta=2\theta=2\cos^2\theta-1$. Substituting, etc., the given equation becomes $\cos4\theta-\cos^2\theta=-\frac{3}{16}$; whence $\cos\theta=\frac{1}{2}$ or $\frac{1}{2}\sqrt{3}$, giving $\theta=60^\circ$ or 30° for *particular* values. [*A. H. Bell.*]

NOTE.—The particular values given for this problem in Bowser's *Treatise on Trigonometry*, page 128, are $\frac{\pi}{2}$, $\frac{2}{3}\pi$.—*Editor.*

Also solved by *P. S. BERG, A. L FOOTE, F. P. MATZ, P. H. PHILBRICK, J. F. W. SCHEFFER C. D. SCHMITT. W. I. TAYLOR*, and *G. B. M. ZEER.*

47. Proposed by LEONARD E. DICKSON, A. M., Fellow in Mathematics, University of Chicago, Chicago, Illinois.

Prove that $(-1)(-1)=+1$.

Solutions by the PROPOSER; G. B. M. ZEER, A. M., Ph. D., Professor of Mathematics in Inter State College, Texarkana, Texas; H. W. DRAUGHON, Olio, Mississippi; P. H. PHILBRICK, M. S., Chief Engineer for Kansas City, Watkins & Gulf Railway Co., Pineville, Louisiana; J H. GROVE, Professor of Mathematics in Howard Payne College, Brownwood, Texas; P. S. BERG, Apple Creek, Ohio; W. I. TAYLOR, Baldwin University, Berea, Ohio; Professor J. F. W. SCHEFFER, A. M., Hagerstown, Maryland; A. L. FOOTE, C. E., Middlebury, Connecticut; and F. P. MATZ, Sc. D., Ph. D., Professor of Mathematics and Astronomy in Irving College, Mechanicsburg, Pennsylvania.

I. *Assuming* the distributive law to hold, $(-1)\{(+1)+(-1)\}$, or 0,